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ABSTRACT

Some theoretical background is presented for the proposition that thinking processes can be measured by determining the levels of cognitive complexity apparent in written interpretations of complex situations. The rationale for scoring interpretations is presented, and some illustrative data are discussed. The approach to measurement of thinking of E. McDaniel and C. Lawrence (1990) recognizes three information processing strands in written interpretations: perception and definition of the situation; imposing an organizing structure; and analysis, support, and elaboration. These strands are used to determine which of the following five levels of cognitive complexity describe the student's work: (1) unilateral descriptions; (2) simplistic alternatives; (3) emergent complexity; (4) broad interpretations; and (5) integrated analysis. The measurement process is illustrated through student responses to a videotape about the manufacture of nuclear weapons. Several studies are reviewed relating scores on the Levels of Cognitive Complexity measure with other measures of school achievement, cognitive ability, and learning styles. In general, the scoring rationale and stimulus materials revealed psychometric properties similar to other available tests of thinking. Implications for educational assessment are discussed. One figure illustrates the model. (SLD)

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LEVELS OF COGNITIVE COMPLEXITY: A FRAMEWORK FOR THE MEASUREMENT OF THINKING

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Abstract

Traditionally, thinking has been defined in terms of the logical processes which lead to warranted conclusions. In dealing with complex situations, however, conclusions may rely less on rules of logic than on the way information is perceived, organized and interpreted. In these processes, cognitive schema, including attitudes, values and past knowledge, function as information processing structures.

These consideration led McDaniel and Lawrence (1990) to develop a procedure for measuring thinking processes by ascertaining the cognitive complexity reflected in student interpretations of open-ended stimulus situations. In this paper, some of the background work for this approach is presented followed by a description of the scoring rationale and some findings obtained with a thinking exercise developed within this framework.

LEVELS OF COGNITIVE COMPLEXITY:
A FRAMEWORK FOR THE MEASUREMENT OF THINKING

This paper will present some of the theoretical background leading to the proposition that thinking processes can be measured by determining the levels of cognitive complexity apparent in written interpretations of complex situations (McDaniel & Lawrence, 1990). The rationale for scoring written interpretations is presented and data obtained using this approach are presented.

In a moment, we will turn to three lines of research which emphasize the cognitive processes which come into play as individuals try to make sense of complex situations. Before examining these lines of research, it is interesting to note that some of the ideas we will be discussing were foreshadowed early in the history of psychology. For example, John Dewey in an 1896 paper, The reflex arc concept in psychology, took issue with the stimulus-response paradigm because in his opinion, it failed to recognize that the perception of a stimulus was, itself, a response. Rather than the separate, distinct phases of perception, interpretation and action, there is but one seamless act. Dewey pointed out that the same stimulus, a sharp sound, would have very different meanings depending on the context. "If one is reading a book, if one is hunting, if one is watching in a dark place on a lonely night, if one is performing a chemical experiment, in each case, the noise has a very different psychical value, it is a different experience" (1896, p.361). The perception of a stimulus is itself an interpretive response.

Interestingly, something of Dewey's position is reflected in Richard Prawat's (1991) contention that conventional information processing models of thinking stress processes which occur after information is in the system, i. e., the classification, organization, storage, and retrieval of information. Prawat favors the more dominant information processing models which give attention to information pick-up and the key role perception plays in cognition, particularly the role that schemas play in actively seeking out new information.

Binet also was fascinated with the variations in responses obtained by asking individuals to respond to the same stimulus material. Following are part of the responses written by his two daughters after viewing a leaf from a chestnut tree (Wolf, 1973, p.124).

Madeleine:

> The leaf that I have in hand is a leaf of a chestnut tree picked up in the autumn, for the folioles are almost all yellow, except for two, and one is half green and yellow.
>
> This leaf is a leaf composed of seven folioles attached to a center that ends in the stem called a petiole which holds the leaf on the tree. The folioles are not all of the same size; out of seven, four are much smaller than the other three.
>
> ...

Alice:

> ... The seven leaves (folioles?) are all very pretty still, the greenish stem has not at all detached itself.
>
> Poor leaf, now destined to fly along the streets, and then to rot, heaped up on many others. It is dead today__ and yesterday it was alive! Yesterday hanging on the branch it was waiting for the fatal blow of wind that would loosen it and carry it off; as a dying person awaits his last agony. ...

These responses of Binet's daughters to the oak leaves illustrate the markedly different approaches which individuals take to situations when their responses are not constrained by the problem task. These differences call to mind the distinctions in cognitive performance elicited by tests of "maximum performance" in contrast to tests of "typical performance" (Messick, 1984). In tests of maximum performance, an individual is instructed to perform a given task as well as possible. In tests of typical performance, subjects are free to respond in ways which reveal their more general and habitual modes of behavior in the absence of prompts or cues.

Most tests of critical thinking have been tasks of maximum performance in that the problems have been well defined and students select the most logical course of action or conclusions based on the given information. No opportunities exist in such tests for the individual to construct and interpret the situation in a manner similar to the responses of Binet's daughters.

These considerations are related to an issue which has received a great deal of scholarly attention (Galotti, 1989), the distinction between "formal reasoning" and "everyday reasoning". In tests of formal reasoning, a well defined problem is set before the student and the essential premises and information are provided. If the student follows logically sound rules of reasoning, the correct answer is obtained.

In everyday reasoning the problems are less well defined, all of the information one needs is rarely available, and there are a number of possible solutions rather than a single answer. In everyday reasoning, the way information is perceived, selected and interpreted play. a major role in formulating solutions.

Again, it may be noted that most widely used tests of critical thinking are constructed within the formal reasoning framework. Students assess the arguments or statements presented in the test, but have no opportunity to formulate their own problems, select relevant information, and come to their own conclusions.

The brief references to the observations of Dewey and Binet highlighting the perceptual and idiosyncratic features of an individual's response raise significant questions for the way thinking is conceptualized and measured. Is thinking the application of logical operations in deciding what to believe or do, or is thinking more accurately characterized as the construction of meanings in complex situations constrained by information processing structures? Is thinking best viewed as a series of inductions, deductions, inferences, and other mental moves related to right reasoning, or is thinking best understood as the way an individual perceives, selects, organizes and interprets information? We shall now examine three lines of inquiry which may help illuminate these questions.

The "describer-explainer" continuum.

Few investigators in the area of thinking and reasoning have made more seminal contributions than Peel (1971) working in England on the development of thinking in adolescents and young adults. Fundamental to Peel's conception of thought is the thinker's evaluation of the actual situation in terms of the possibilities which are suggested by it: "I begin with an assertion. Above all else the adolescent and young adult apprehend the inconsistencies between the actual and the possible. They are impelled to the opinion and action which characterizes their lives by a drive to reconcile this actuality of their existence with the possibilities they themselves envisage . Usually they strive to modify the actual. This going forward and outward to conceive of possibilities beyond the limits of their environment is the central feature of their intellectual life" (p.13).

Peel goes on to define possibilities as "ideas, theories, hypotheses, opinions, values, concepts, causes and analogies and comparisons with previous experience" (p 15). Reconciliation of the possible and the actual requires both understanding of and judgements about the existing

situation. Peel asserts that understanding is revealed by the act of explaining as opposed to mere descriptions of events. "The main task in this monograph then is to investigate the understandings and judgment of adolescents by calling for explanations which may be set on a description-explanation scale" (p. 16).

Peel's definition of understanding includes some of the logical processes referred to by other writers, but, in addition, features the use of broad concepts. For Peel, understanding means "...understanding a reasoned discourse in cause-and-effect relations, seeing a problem in terms of higher-level concepts, and sensitivity to formal relations and a capacity to follow deductive arguments" (p. 18.).

Peel stresses the ability to imagine alternative conditions not clearly suggested by the problem situation. "The distinction between content-dominated answers and imaginative responses invoking explanations is crucial in this study of adolescent thinking. ... The transition from content-dominated to possibility evoking answers seemed to be the predominant feature of early and mid-adolescent thinking (p. 26)."

Peel reports a number of exercises designed to elicit understandings and judgements from students. In a typical exercise originally used by Rhys (1964), Peel presented subjects with a paragraph describing an Andean farmer who cut down the forest and planted a crop which produced a profitable harvest. Other farmers followed his example. Within a short time, the fertile soil was eroded away and the farmers were left trying to till their barren soil. After reading the paragraph, students were asked, "Why did the deep fertile soil cover disappear and make farming impossible?"

Peel scored the student responses on a "describer-explainer" scale. Low scorers responded to such stories with concrete descriptions limited to a recapitulation of the information given. Their explanations amounted to little more than descriptions. They exhibited little in the way of abstract concepts, comparisons, evaluations, or analytic insights. High scorers saw causal connections and drew on their world knowledge of how things work to generate explanations. They also used broader concepts or higher level ideas in constructing their explanations.

We shall see many of the themes defining higher order thinking introduced by Peel reflected in the work of Perry's study of intellectual development during the college years.

Intellectual Development

Perry (1970) views students' responses to problematic situations as reflective of their general intellectual and moral development. Perry's ideas are based on extensive interviews with students at Harvard University. During the freshman year, students appear to view the world as divisible into simple "black-white" categories. Problematic situations are quickly broken into either-or compartments: we-them, right-wrong, good-bad. Authorities have answers and there is a feeling that everything will turn out alright if one relies on hard work and obedience.

By the senior year, most students have reached a more intellectually mature level. Students see knowledge and values as contingent on circumstances and relative from person to person and place to place. At a still higher level, students accept the necessity of living in a relativistic and uncertain world, but learn to make commitments which reflect their values and come to see these commitments as an ongoing activity which expresses their particular life styles.

Perry's contributions to the conceptualization and measurement of thinking has been reviewed by Moore (1991) in this symposium, and there is little need to describe it further. I would like to emphasize that Perry's work helps us see a distinction in thinking processes between the relatively immature tendencies to simplify the world and the more mature tendencies to accept a complex world which is open to many interpretations and which guarantees few right answers. This continuum from simple to complex cognitive processes is further elaborated by cognitive psychologists viewing thinking as contingent on information processing structures.

Information processing structures

Schroder, Driver and Streufert (1967) make a significant contribution in their analysis of the way concepts, attitudes, needs and norms function as information processing structures which markedly influence perceptions and the ways perceptions are integrated into beliefs and actions. Individuals with more complex cognitive structures are able to see more dimensions and to make finer distinctions in situations they encounter. They are also able to combine and integrate these perceptions in more complex ways.

According to Schroder and his colleagues, individuals with low cognitive complexity exhibit thinking processes marked by (1) categorical, black-white thinking, (2) minimizing conflict, (3) seeking causes of behavior in

external circumstances, and (4) compartmentalization and abrupt shifts in categories. With greater cognitive complexity, there is (1) movement away from absolutism, (2) perception of a less deterministic system, (3) perception of a situation from two or more points of view and (4) greater use of internal processes in generating possibilities.

The work of Schroder et al. points to cognitive structures, rules, or habits for making meaning and generating knowledge from encounters with the environment. These information processing structures lie on a continuum ranging from simple to complex. Individuals with simple cognitive structures tend to reduce situations to simplistic categories which can be readily managed. Individuals with more complex cognitive structures can generate theoretical frameworks which organize complex events and relationships.

It is striking to note the general similarity in the analysis of thinking processes achieved by these three lines of inquiry by investigators working at different times and in different places. At the lower end of the thinking process. all of these investigators stress the need to stay close to the given material, to apply narrow concepts, to see simplistic answers, and to seek certainty and avoid complexity. At higher levels of thinking, the cognitive processes are marked by a tendency to apply broad generalizations and world knowledge as individuals go beyond the material given to construct alternate possibilities and theoretical frameworks that accommodate complexity and offer meaningful interpretations.

Levels of cognitive complexity - An approach to the measurement of thinking

We have attempted to build on these three lines of research to develop an approach to the measurement of thinking (McDaniel & Lawrence, 1990). In this approach, students are confronted with a complex situation which is open to a variety of interpretations. Student written responses are scored using an explicit scoring rationale which allows the grader to assign a rating representing the level of cognitive complexity expressed in the response.

We have used as stimulus material the first 15 minutes of a video tape originally broadcast as an ABC news presentation, The Bomb Factories. This tape shows industrial plants which make nuclear weapons and describes problems with plant safety and environmental pollution associated with the handling and disposal of nuclear wastes. After viewing the tape, students write a summary statement describing their reactions and interpretations of the situation.

In scoring the responses, the rater attends to three "strands" or cognitive processes which help determine the level of complexity reflected in the students' reactions. These strands related to (1) the way the student perceives and defines the situation, (2) the kind of organizing structure the student uses to help make sense of the situation, and (3) the way the student analyzes the situation and supports a position.

Based on the way the student performs with respect to these three information processing strands, the scorer assigns a rating of 1 to 5 to indicate the level of cognitive complexity represented in the written productions.

At the risk of tremendously oversimplifying the scoring rationale, I have constructed Figure 1 as a way of providing an advanced organizer to illustrate the way the strands are related to the levels of cognitive complexity.

Insert Figure 1 about here

The three columns of this figure represent the three strands of cognitive processes and, reading from bottom to top, one can see that for the first strand (Perceiving and Defining the Situation), such perceptions range from a low of "Ignores Information, simplifies" to a high of "New Perspectives".

The five rows of the figure list the levels of cognitive complexity, and reading across the first row, one can see that Level 1, Unilateral Descriptions, is defined by Ignoring knowledge, simplifying, accepting the framework provided, and supporting a position by descriptions and paraphrases of the given material.

Again, Figure 1 is a schematic showing the relationships among the strands and levels of complexity. The fuller descriptions of the three information processing strands and the five levels of cognitive complexity are presented in McDaniel and Lawrence (pp 24-27):

Perception and Definition of the Situation

This strand describes the way the student represents or encodes the situation. Rarely is all of the information used. The student perceives and selects salient features to characterize the situation and give it meaning. The student's initial perceptions define the complexity seen in the issues presented. The representation of the problem sets the limits and opens the possibilities for further

elaboration and analysis.

At the lower end of the strand, the student simplifies the situation and ignores information. At the upper end of the strand, the student preserves the complexity in the situation and incorporates divergent information.

Imposition of an Organizing Structure

This strand describes the construction of an organizing structure that helps make sense of the situation and provides a basis for interpretations. This structure includes a frame of reference within which the events are interpreted. This frame of reference reflects the student's values, concerns, and world knowledge.

Additionally, the interpretations of the situation are constructed around certain organizing ideas, or nodes. The organizing ideas may be relatively narrow and fact-like or broader and more inclusive. Imposing a simple structure (conventional framework, few nodes, narrow concepts) leads to superficial and obvious interpretations. Imposing a complex structure (interpretive framework, many nodes, broad concepts) leads to deeper analysis and integrated, comprehensive interpretations.

At the lower end of the strand, the student accepts and simplifies the framework explicitly provided. The interpretation employs narrowly defined concepts and few nodes. The student adds no new ideas or perspectives. At the upper end, the student extends the framework, bringing in world knowledge and value positions not implied by the situation. The interpretation in built around broad concepts which facilitate reorganizing, restructuring and reconceptualizing the problem situation.

Analysis, Support, and Elaboration

This strand describes the way the student analyzes the situation and supports a position. The progression from low to high is marked by a shift from descriptions to explanations. Describing is characterized by restatements of the given information coupled with assertions rather than reasons. Explaining is characterized by an integrated network of relationships.

At the lower end of the strand, the student paraphrases information and uses assertions, simple rules, and appeals to authority. At the upper end, the student constructs networks of causal relationships, applies principles, uses analogies, generalizes, and extrapolates.

These strands are used by scorers in deciding which of five levels of thinking to assign any given student's

response. These levels are described next.

Levels of Cognitive Complexity

Level 1: Unilateral Descriptions

Simplifies the situation. Focuses on one idea or argument. Does not identify alternatives. Brings in no new information, meaning, or perspectives. Makes "good-bad" and "either-or" assertions. Appeals to authority or simple rules. Information is simply paraphrased, restated or repeated.

Level 2: Simplistic Alternatives

Identifies simple and obvious conflicts, but the conflicts are not pursued or analyzed. Develops a position by dismissing or ignoring one alternative and supporting the other with assertions and simple explanations rather than through deeper assessment of the situation.

Level 3: Emergent Complexity

Identifies more than one possible explanation or perspective. Complexity is established and preserved. New elements are introduced. Supports position through comparisons and simple causal statements.

Level 4: Broad Interpretations

Uses broad ideas to help define and interpret the situation. Manipulates ideas within the perspective established. Has a clearly recognizable explanatory theme. Ideas are integrated into "subassemblies" each supporting a component of the explanation.

Level 5: Integrated Analysis

Restructures or reconceptualizes the situation and approaches the problem from a new point of view. Constructs a network of cause-and-effect relationships. Ideas are Integrated and extrapolated. Arrives at new interpretations by analogy, application of principles, generalizations, and world knowledge. Constructs an organizing framework, sketches connections, and predicts consequences (McDaniel & Lawrence, 1990, pp. 24-27).

A number of examples of the application of this scoring rationale are provided by McDaniel and Lawrence, and two of these are presented here along with the original comments to illustrate both a low and a high level response.

Level 1. Unilateral Description

I think that the government has done a lousy job in the handling of these factories. The bomb factories are all outdated without modern improvements. There have been several accidents and health hazards but yet nothing is done. No improvements are attempted and whenever the subject is brought up it is swept under the rug. Hiding the facts is only going to make the situation worse and endanger more lives. The government doesn't even bother to make a public announcement that they have made a mistake or that there is a problem.

In the above example, there is essentially a single idea, the government has done a poor job of handling the bomb factories. No alternatives are mentioned and no new information is brought in. The supporting statements repeat or paraphrase the information given in the material (McDaniel & Lawrence, 1990, p.54)

Level 5. Integrated Analysis.

After seeing the videotape and reading the article, it is obvious America has a problem disposing of its nuclear waste. Although just two plants were mentioned, I'm sure that nearly every nuclear plant in the country is in some way illegally disposing of nuclear waste. I think this is a great injustice to Americans, especially today when so many Americans are concentrating on their health. In the everyday hustle and bustle Americans can be inconsiderate and uncaring, but when major issues come up I think Americans form strong opinions and are willing to unite together. This is such a case where Americans are realizing that we don't need as many warheads anymore and that production must slow down. We must concentrate our efforts, time, and money on finding out how to safely dispose of nuclear waste, and all other industrial waste, and how to safely disarm and store nuclear weapons.

Nuclear energy has only been used for forty or fifty years. I consider us to still be in the early stages of nuclear energy where we can't realize the full potential and dangers of nuclear energy. American industry boomed in the late 1800's and was a heavy polluter. Now after 100 years of heavy industry we are clamping down on pollution with our knowledge of industry. I hope that we can learn from the past and put restraint on our nuclear energy industry now instead of 50 more years from now.

> Most importantly I think we must immediately begin extensive research on how to safely control the nuclear waste that is so quickly created.
>
> The most notable aspect of this response is the construction of a global organizing framework. An almost sociological view of Americans is presented. Historical ideas are woven into an integrated frame of reference: trends in science/industry and human interventions concerning our past, present, and future lives. Ideas are well integrated and extrapolated. The bomb factories are viewed as one instance of the more general problem of industrial pollution. Nuclear energy is perceived as a young industry for which the future potential and dangers are unknown. There is extensive use of generalizations and world knowledge (McDaniel & Lawrence, 1990, pp. 61-62).

Discussion of "levels of cognitive complexity" approach to measuring thinking

Clearly, this approach to measuring thinking processes is relatively new and untried. It represents an attempt to measure "everyday" reasoning in open situations as opposed to formal reasoning in well defined situations. The scoring focuses on the way the student perceives the problem, constructs an organizing frame of reference, and proceeds to analyze, establish, and extrapolate an interpretive position.

One of the disadvantages of this approach to measuring thinking processes is that the scoring is labor intensive. Additionally, in spite of the detailed scoring rationale, classification of a student's response is open to subjective judgments. Chris Lawrence and I obtained an inter-rater reliability of .80 between our independent scoring of 39 responses to The Bomb Factories written by eleventh grade students.

My students and I have done a number of studies relating scores on Levels of Cognitive Complexity with other measures of school achievement, cognitive ability, and learning styles. For example, scores on The Bomb Factories were correlated with semester grades in history at .39 for 54 students in grade 8; .37 for 78 students in grade 11, and .57 for 18 students in grade 11.

For 72 students in grade 11, scores on The Bomb Factories correlated .46 with an independent holistic rating of a writing sample administered and scored as part of the Indiana State-wide competency testing. This correlation may indicate that scores on the Bomb Factories reflect some element of writing skill. The Bomb Factories scores may also reflect some component of general verbal ability. A

correlation of .39 was obtained with the SAT-Verbal scores for 53 undergraduate students at Purdue.

There is a consistent pattern of moderately high correlations between The Bomb Factories and learning style measures reflecting a tendency to engage in and like thinking and problem solving. These correlations range from .33 at the eighth grade level to .41 at the college level.

Of most importance are relatively high correlations between the Bomb Factories and two exercises designed to measure thinking processes. In the first study, 60 eleventh grade students saw a video tape about the Holocaust and answered such questions as "Could something like the Holocaust happen again? Explain your answer" (McDaniel & Thompson, 1989). Responses were scored using a rationale very similar to that of the Bomb Factories. Subsequently, these students completed the Bomb Factory exercise. The correlation between the scores for The Holocaust and The Bomb Factories was .54.

In a second study (Wood & McDaniel, 1990) 18 eleventh grade students completed a computer simulation of an investigation into the reasons for the complete surprise of the Americans at the attack on Pearl Harbor. After obtaining and reviewing background information about the attack, students wrote summaries indicating who might be held accountable for our lack of preparedness. The summaries were scored using the scoring rationale for the Bomb Factories. A correlation of.65 was obtained between scores on the Pearl Harbor exercise and the Bomb Factories.

In an unpublished paper by another student, Kurt Taube, a correlation of .08 was obtained with the Watson-Glaser Critical Thinking Test and .45 with the Ennis Weir Critical Thinking Essay Test.

In general, the scoring rationale and stimulus materials described in this section reveal psychometric properties which are about equal to other tests of thinking processes which are available. I am not aware of validity coefficients for published tests of thinking which involve actual thinking exercises as a criterion measure. This is the case, I suspect, because valid exercises of thinking processes are virtually non-existent. We have a very interesting study in progress under the direction of Ching-Kuch Chang in which we are observing the search strategies of college students moving freely through a hyperstack program containing 104 topics on the Vietnam War (Gabel, 1989). We are predicting that students with high levels of cognitive complexity will show more directed, as opposed to random, searches and will write more integrated, complex summaries of the information they select. This kind of

study suggests the need for behaviorally oriented experimental work which allows us to observe what students actually do in an open situation with many opportunities for the selection, organization, and interpretation of information. Such exercises may provided badly needed criterion measures useful in validating various approaches to the measurement of thinking.

For teachers interested in immediate applications, the "levels of cognitive complexity" approach seems appropriate for identifying how students perceive and define problems and how they organize and interpret information. Quite possibly stimulus situations can be constructed which are much more closely tied to the content being taught in a particular class. In any event, the scoring rationale should be useful in detecting tendencies to simplify situations, to describe rather than explain, and to think within very narrow limits. The scoring rationale should also help teachers identify tendencies to preserve complexity, seek causal explanations, and use broad concepts in arriving at interpretations. The major point is that the scoring rationale is completely general and may be applied to any interpretations of situations which are rich enough to provide opportunities for different interpretations.

The studies reported suggest that this approach to measuring thinking processes is consistent with the emergence of intellectual maturity as described by other investigators. Further, it may be argued the development of more complex cognitive structures is marked by less egocentric and less ethnocentric ways of viewing the world. One of the more general aims of education is the development of people who are able to view the world in all of its complexity without needs to simplify, distort, avoid issues, and think in stereotyped forms. The method of scoring student productions for levels of cognitive complexity seems to provide a measure of thinking processes which is consistent with these educational goals. The procedure is also general enough to fit a variety of subject matter areas. In this emerging field of measurement of thinking processes, this approach may point the way for substantial future developments.

References

Dewey, J. (1896). The reflex arc concept in psychology. Psychological Review, 3(4), 357-370.

Gabel, P. (1989). The Vietnam war: A hypercard history book (Ver. 2.01). Scotts Valley, CA: Regeneration Software.

Galotti, K. M. (1989). Approaches to studying formal and everyday reasoning. Psychological Bulletin, 105(3), 331-351.

McDaniel, E. & Lawrence, C. (1990). Levels of cognitive complexity: An approach to the measurement of thinking. New York: Springer-Verlag.

McDaniel, E. & Thompson, T. (1989, June). The Holocaust: A prototype exercise to measure thinking. Paper presented at the Fifth National Conference on Thinking, Cincinnati, OH.

Messick, S. (1984). The nature of cognitive styles: Problems and promise in educational practice. Educational Psychologists, 19(2), 59-74.

Moore, W. (1991, April). The Perry scheme of intellectual and ethical development: An introduction to the model and two major assessment approaches. A paper presented at the annual meeting of the American Educational Research Association, Chicago.

Peel, E. A. (1971). The nature of adolescent judgement. New York: Wiley-Interscience.

Prawat, R. (1991). The value of ideas: The immersion approach to the development of thinking. Educational Researcher, 20(2), 3-10.

Perry, W. G. (1970). Forms of intellectual and ethical development in the college years: a scheme. New York: Holt, Rinehart and Winston.

Rhys, W. T. (1964). The development of logical thought in the adolescent with reference to the teaching of geography in the secondary school. Unpublished M.ED. Research, Birmingham University.

Schroder, H. M., Driver, M. J., & Streufert, S. (1967). Human information processing: Individuals and groups functioning in complex social situations. New York: Holt Rinehart and Winston.

The Bomb Factories. An ABC News Special Report.

Wolf, T. H. (1973). Alfred Binet. Chicago, IL: The University of Chicago Press.

Wood, J & McDaniel, E. (1990, February). Correlating the results of a computer-based simulation with various achievement and affective variables. Paper presented at the annual meeting of the Eastern Educational Research Association, Clearwater, FL.

Figure 1. Strands of cognitive processes which help define levels of cognitive complexity.

Level of Complexity	Perception & Definition of Situation	Imposition of Organizing Structure	Analysis, Support & Explanation
5. Integrated Analysis	New perspectives	Reconceptualizes & restructures	Network of relationships
4. Broad Interpretations	Broad concepts	Interpretive ideas	Explanatory theme
3. Emergent Complexity	Preserves complexity	Multiple perspectives	Simple causal statements
2. Simplistic Alternatives	Obvious conflicts	Narrow concepts	Assertions
1. Unilateral Description	Ignores knowledge, simplifies	Accepts framework provided	Descriptions, paraphrases